

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 0 758 822 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
01.03.2006 Bulletin 2006/09

(51) Int Cl.:
H04J 3/16 (2006.01)

(21) Application number: **95202191.3**

(22) Date of filing: **11.08.1995**

(54) **Method and arrangement for dynamic allocation of bandwidth in a TDM/TDMA network**

Verfahren und Anordnung zur dynamischen Bandbreitenzuordnung in einem TDM/TDMA-Übertragungssystem

Méthode et circuit pour l'allocation dynamique de bande passante dans un système de communication TDM-AMRT

(84) Designated Contracting States:
BE DE ES FR GB IT NL SE

(43) Date of publication of application:
19.02.1997 Bulletin 1997/08

(73) Proprietor: **Alcatel**
75008 Paris (FR)

(72) Inventors:
• **Sierens, Christiaan Hendrik Jozef**
B-2640 Mortsel (BE)
• **Vandenabeele, Peter Michel Noel**
B-2500 Lier (BE)
• **Van Wonterghem, Geert Arthur Edith**
B-9900 Eeklo (BE)

(74) Representative: **Narmon, Gisèle Marie Thérèse et al**
Alcatel Bell N.V.
Intellectual Property Department
Francis Wellesplein 1
2018 Antwerpen (BE)

(56) References cited:

EP-A- 0 493 287 **EP-A- 0 621 708**
DE-A- 4 233 581 **US-A- 4 949 395**

- **INTEROPERABILITY IN BROADBAND NETWORKS, PROCEEDINGS OF INTERWORKING 94 - 2ND INTERNATIONAL SYMPOSIUM ON INTERWORKING, SOPHIA ANTIPOLIS, FRANCE, 4-6 MAY 1994, 1994, AMSTERDAM, NETHERLANDS, IOS PRESS, NETHERLANDS, pages 238-249, MOLLENAUER J F ET AL 'Cable-TV protocols for metropolitan and regional communication systems'**
- **VANDENABEELE P.; SIERENS C.: 'ATM-based Hybrid Fiber Coax System' IEEE 802.14 CONTRIBUTION May 1995, DALLAS, pages 1 - 18**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 0 758 822 B1

Description

[0001] The present invention relates to a central station and a terminal station to perform a method for Time Division Multiplexing (TDMA) management and to frames used in this method as described in the preambles of claims 1, 2 and 3 respectively.

[0002] Such a central station, terminal station and frames are already known in the art e.g. from the *IEEE 802.14 contribution (Dallas May 1995) "ATM-based Hybrid Fiber Coax System"* by Peter Vandenabeele and Chris Sierens. Therein a system is described over which broadcast video and interactive services are provided by a central station for a plurality of terminal stations. The video services are provided by means of downstream RF channels containing an MPEG2 Transport Stream (MPEG2-TS), whilst the interactive services are provided using downstream RF channels containing a frame with a combination of Asynchronous Transfer Mode (ATM) cells and TDMA control information, i.e. Access Grant Information (AGI) to control the sending of upstream frames from the terminal station to the central station. Two types of mode are defined in this document : a standard mode and a high mode. In standard mode the frame contains 748 bytes split in 6 bytes for TDMA control information and the rest for ATM cells, and in high mode the frame contains 6 bytes for TDMA control information and 181 bytes for ATM cells. The latter frame is used for high upstream bit rates.

[0003] Since the number of bytes foreseen in these frames for TDMA signalling and thus also the number of AGI is restricted, it is clear that there is also a restriction in this system on the upstream data rate and on the relation between the upstream and downstream rates, the upstream data rate being the sum of the data rates of all upstream channels controlled by one downstream channel. Additionally only a fixed number of terminal stations can be controlled by one downstream frame

[0004] An object of the invention is to provide a central station and a terminal station of the above known type but which is more flexible with respect to transmission rates and to the number of terminal stations to be controlled.

[0005] According to the invention this object is achieved by the central station, terminal station, and frame described in claims 1, 2 and 3 respectively.

[0006] Indeed, by foreseeing in the superframe an overhead portion which is flexibly adaptable, this portion and thus also the TDMA control information such as the AGI and consequently the number of upstream channels controlled by one downstream channel can increase or decrease according to the supported rates and to the number of terminal stations to be controlled. Moreover the superframe is suited for inband as well as for outband signalling.

[0007] To enable the terminal stations to decode the downstream frame, the stations are informed about the size of this overhead portion either by inserting informa-

tion related to this size in the overhead portion, by transmitting this information to the terminals in operation and maintenance frames or by preconfiguring this information in the terminal stations. The latter way of informing the terminal stations about the size of the overhead portion implies that whenever this size is adapted the preconfigured information has also to be adapted, e.g. by operator intervention.

[0008] The above mentioned and other objects and features of the invention will become more apparent and the invention itself will be best understood by referring to the following description of an embodiment taken in conjunction with the accompanying drawings wherein Fig. 1 is a representation of a downstream frame structure and associated upstream burst structures according to the invention, and

[0009] Fig. 2 is a schematic representation of a network system according to the invention.

[0010] Fig. 1 represents a downstream frame structure DS and an associated upstream burst stream US structure for use in a network system as shown in Fig. 2 wherein downstream frames DS are transmitted from a central station CS to a plurality of terminal stations TS1 - TSn over the cascade connection of a common transmission path c and individual transmission paths i1-in, and wherein upstream bursts UB are transferred from the terminal stations to the central station via time division multiple access (TDMA). Such a network is for instance used for interactive service as video on demand and video broadcasting. In the considered embodiment the upstream and downstream rates are considered equal, e.g. 2.048 Mb/s, to simplify the description of the working of the system, but the invention is equally well applicable to systems where the upstream and downstream rate are different. The upstream channel is shared by a plurality of terminal stations, 4 in the considered embodiment, and is thereto divided in time slots 1, 2, 3, 4, allocated to the terminal stations by means of access grant information or transmit enable (TEA) information included in DS.

[0011] The downstream frame is 204 bytes long and is compatible with a Digital Video Broadcast (DVB) frame that is standardized for distribution of MPEG-TS over cable. The frame consists of an MPEG2 frame of 188 bytes, to which a Reed-Solomon FEC of 16 bytes is added for error correction on the ATM part or on both the ATM and the TDMA control block part. The first byte of this frame is a predetermined synchronisation byte S. Byte 2 to 188 can be used for user data. Using the frame as a basic block (row), a superframe is constructed of 8 consecutive frames. The superframe is divided in columns containing dedicated blocks. The column containing the first byte of every frame contains a synchronization byte S of the DVB frame as mentioned earlier. The next 8 columns form a TDMA Control Block TCB which contains 1 bit for superframe synchronization S', a second bit for specifying a counter C for slot synchronization of the TDMA and per row maximum 4 Transmit Enable Addresses TEA1-TEA4 for specification of the terminal station allowed to send

information in a corresponding timeslot of the upstream channel. The counter value composed of the above mentioned second bit in the 8 rows is used for synchronization of an 8 bit cyclic counter for the upstream TDMA as explained later on. The next six bits of each row of TCB are reserved for other use

[0012] Each frame of the upstream burst is 60 bytes long and consists of a preamble, an ATM cell, an error code and a guard band. The parts of the frames are not shown in Fig. 1, and will not be considered further since they are not relevant for the invention.

[0013] In the following the principle working of the upstream TDMA is explained. More detailed information with respect to this working can be found in the earlier cited IEEE contribution and in the related European Patent Application EPA 95201108.8

[0014] Two features are required to realize TDMA : slot synchronization, i.e. determining at what instant in time or in which time slot a terminal station may transmit information, and terminal addressing, i.e. indicating which terminal station may send upstream information.

[0015] The slot synchronization is executed by means of cyclic synchronization counters. The central station has a master counter that counts up to a predetermined value, then returns to zero and starts counting again. This counter counts with the speed of the downstream bytes. At each zero crossing of that counter, one terminal station may send an upstream burst. Every terminal station has a similar local counter, the slave counter that also counts up to the same predetermined value as the central station, and at the same speed (one increase per received downstream byte). To synchronize the counters in all the terminal stations with the central counter, the value of the latter counter is broadcast on regular intervals by the central station to the terminal stations, in the field C of the downstream frame. In case of equal upstream and downstream rate as in the described embodiment, the predetermined value of the counters equals the length of the upstream burst. For embodiments with a downstream rate which is higher than the upstream rate, the predetermined counter values have to be adapted accordingly. For the present case of an upstream burst length of 60 bytes, i.e. 58 transmitted bytes and a guard band of 2 bytes, there is an average of $204/60 = 3.4$ upstream bursts per downstream frame. To be noted that an upstream burst length of 68 would ensure to have exactly 3 upstream channels for one downstream channel.

[0016] The TEAs listed in the downstream frame indicate which terminal station may upon the consecutive zero crossing of its counter transmit an upstream burst. If 4 upstream bursts have to start during a specific downstream frame, then 4 TEA's will be required in the corresponding row of the TCB part of the downstream frame. If only 3 upstream bursts have to start, the fourth TEA is assigned a zero value by the central station. Typically, a row of the TCB controls the burst starting transmission during the next frame. It cannot control transmission dur-

ing the current frame, since some latency is required for processing the TEA in the terminal station.

[0017] To be noted that use could be made of special code TEAs as a result of which any terminal station would be allowed to transfer upstream information, thereby realizing a combination of TDMA and of the Aloha or contention principle. Acknowledges could then be broadcast in operation and maintenance messages.

[0018] A more detailed description of the slot synchronization and terminal addressing and of the practical implementation thereof in the central station and in the terminal stations can be found in the above mentioned IEEE contribution and the related European Patent Application.

[0019] Supposing a future extension of the services, it may be required to offer more upstream bandwidth to the terminal stations, i.e. to have more upstream channels being controlled by one downstream channel. In this case, the TDMA control block of 8 columns wide is duplicated a number of times in the superframe at the cost of the ATM block. The value of the TDMA control block is communicated to the user stations to enable them to decode the superframe. This communication can be done in several ways, by including the value in the superframe and more specifically in the earlier mentioned bits for further use, by including the value in operation and maintenance (OAM) downstream frames, by operator intervention.

[0020] In a similar way, the size of the TDMA control block can be adapted in case of changed configuration, i.e. increase or decrease of the number of terminal stations, or when for instance upstream frame of 68 bytes are used and only 3 upstream channels have to be controlled by an upstream channel.

[0021] To be noted that also the size of the frame part containing the FEC code could be made flexible.

[0022] No further details are given with respect to the realization of embodiments of a central station and of terminal stations according to the invention, since for a person skilled in the art this realization is obvious based on the above functional description of the invention and taking into account the known implementation of a system as described in the referred documents.

[0023] It has to be noted that although in the considered embodiment the number of rows of the superframe is taken equal to 8, this is not by way of restriction. Indeed, the number of rows can have any value. In the considered embodiment a number equal to 8 was chosen because of the number of bits in a byte. The number of rows could in another advantageous implementation be taken equal to 53 which corresponds to the number of bytes in an ATM cell.

[0024] Also to be noted that the connection between the central station and the terminal station can be realized by means of for instance a satellite communication path or a cellular radio network path or a hybrid fiber coax network comprising the cascade connection of an optical fibre, a converting unit including an electro-optical con-

vertor and an opto-electrical converter, and coax cables, all not shown in Fig. 2. In the latter network subgroups of terminal stations can be defined which are separated in downstream and upstream direction by frequency division multiplexing, each these subgroup including terminal stations which share a single upstream carrier by time division multiple access

[0025] Additionally, the above described principle of having a flexible overhead part could be applied to the upstream frames.

[0026] While the principles of the invention have been described above in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

Claims

1. Central station (CS) for a time division multiple access system in which said central station is coupled to each of a plurality of terminal stations (TS1-TSn), said central station including generation means for generating downstream frames including access grant information (TEA1-TEA4), and transmission means to transmit said downstream frames to said terminal stations to allow said terminal stations to transfer upstream frames (US) to said central station in time slots assigned thereto by means of said access grant information, **characterized in that** each of said downstream frames is a superframe having a matrix structure with rows and columns, a first portion and a second portion of said matrix structure being an overhead portion (S, TCB) and an information portion (ATM) respectively, and that said generation means is adapted to insert said access grant information in said overhead portion and to flexibly adjust the size of said overhead portion according to a predetermined size value computed from said access grant information.
2. Terminal station (TS1;...;TSn), for a time division multiple access system in which a central station (CS) is coupled to a plurality of terminal stations (TS1-TSn), each of said plurality of terminal stations being substantially the same to one another said terminal station including reception means for receiving a downstream frame (DS) transmitted by said central station via said system to said terminal station and interpretation means for interpreting said downstream frame, said downstream frame including access grant information (TEA1-TEA4) to allow said terminal stations to transfer upstream frames to said central station in time slots assigned thereto by means of said access grant information, **characterized in that** each of said downstream frames (DS) is a superframe having a matrix structure with rows and columns, a first portion and a second portion of said

matrix structure being an overhead portion (S, TCB) and an information portion (ATM) respectively, the size of said first portion being variable and that said interpretation means is adapted to detect and to interpret said access grant information in said overhead portion taking into account information related to the size of said overhead portion, said information either having been communicated to said terminal station by said central station or being preconfigured.

3. Frame (DS) for transmission, suitable for a time division multiple access system including a central station (CS) coupled to a plurality of terminal stations (TS1-TSn), from said central station to said terminal stations, said frame including access grant information (TEA1-TEA4) to allow said terminal station to transfer upstream frames (US) to said central station, **characterized in that** said frame (DS) is a superframe having a matrix structure with rows and columns, a first portion and a second portion of said matrix structure being an overhead portion (S, TCB) and an information portion (ATM) respectively, said overhead portion including said access grant information (TEA1-TEA4) and the size of said overhead portion being variable.
4. Frame according to claim 3, **characterized in that** said overhead portion is divided in two subportions, one of which contains an error correction code.

Revendications

1. Station centrale (SC) pour un système d'accès multiple par répartition dans le temps dans lequel ladite station centrale est couplée à chacune d'une pluralité de stations terminales (ST1 à STn), ladite station centrale incluant un moyen de génération pour générer des trames en sens descendant incluant des informations d'attribution d'accès (TEA1 à TEA4), et un moyen de transmission pour transmettre lesdites trames en sens descendant vers lesdites stations terminales afin de permettre que lesdites stations terminales transfèrent des trames en sens montant (upstream, US) vers ladite station centrale dans des tranches de temps qui leur sont allouées au moyen desdites informations d'attribution d'accès, **caractérisée en ce que** chacune desdites trames en sens descendant est une supertrame ayant une structure de matrice avec des rangées et des colonnes, une première portion et une seconde portion de ladite structure de matrice étant une portion d'en-tête (S, TCB) et une portion d'informations (ATM) respectivement, et **en ce que** ledit moyen de génération est adapté pour insérer lesdites informations d'attribution d'accès dans ladite portion d'en-tête et pour ajuster de façon flexible la taille de ladite portion d'en-tête conformément à une valeur de taille prédéter-

minée calculée à partir desdites informations d'attribution d'accès.

2. Station terminale (ST1 ; ... ; STn), pour un système d'accès multiple par répartition dans le temps dans lequel une station centrale (SC) est couplée à une pluralité de stations terminales (ST1 à STn), chaque station de ladite pluralité de stations terminales étant essentiellement identique les unes par rapport aux autres, ladite station terminale comprenant un moyen de réception pour recevoir une trame en sens descendant (downstream, DS) transmise par ladite station centrale par l'intermédiaire dudit système vers ladite station terminale et un moyen d'interprétation pour interpréter ladite trame en sens descendant, ladite trame en sens descendant comprenant des informations d'attribution d'accès (TEA1 à TEA4) pour permettre que lesdites stations terminales transfèrent des trames en sens montant vers ladite station centrale dans des tranches de temps qui leur sont allouées au moyen desdites informations d'attribution d'accès, **caractérisée en ce que** chacune desdites trames en sens descendant (DS) est une supertrame ayant une structure de matrice avec des rangées et des colonnes, une première portion et une seconde portion de ladite structure de matrice étant respectivement une portion d'en-tête (S, TCB) et une portion d'informations (ATM) respectivement, la taille de ladite première portion étant variable et **en ce que** ledit moyen d'interprétation est adapté pour détecter et pour interpréter lesdites informations d'attribution d'accès dans ladite portion d'en-tête en tenant compte des informations relatives à la taille de ladite portion d'en-tête, lesdites informations ayant soit été communiquées à ladite station terminale par ladite station centrale ou étant préconfigurées.
3. Trame (DS) pour la transmission, adaptée à un système d'accès multiple par répartition dans le temps comprenant une station centrale (SC) couplée à une pluralité de stations terminales (ST1 à STn), à partir de ladite station centrale vers lesdites stations terminales, ladite trame comprenant des informations d'attribution d'accès (TEA1 à TEA4) pour permettre que ladite station terminale transfère des trames en sens montant (US) vers ladite station centrale, **caractérisée en ce que** ladite trame (DS) est une supertrame ayant une structure de matrice avec des rangées et des colonnes, une première portion et une seconde portion de ladite structure de matrice étant une portion d'en-tête (S, TCB) et une portion d'informations (ATM) respectivement, ladite portion d'en-tête incluant lesdites informations d'attribution d'accès (TEA1 à TEA4) et la taille de ladite portion d'en-tête étant variable.
4. Trame selon la revendication 3, **caractérisée en ce**

que ladite portion d'en-tête est divisée en deux sous-portions, l'une d'entre elles contient un codage de correction d'erreur.

Patentansprüche

1. Zentralstation (CS) für ein Zeitmultiplexsystem mit Vielfachzugriff, in dem die Zentralstation mit jedem aus einer Vielzahl von Endgeräten (TS1-TSn) gekoppelt ist, wobei die Zentralstation Erzeugungs-Mittel enthält, um Downstream-Rahmen zu erzeugen, die Zugriffs-Gewährungs-Informationen (TEA1-TEA4) enthalten, und Sende-Mittel enthält, um die Downstream-Rahmen zu den Endgeräten zu senden, um es den Endgeräten zu erlauben, Upstream-Rahmen (US) in Zeitschlitzten zur Zentralstation zu übertragen, die dafür mittels der Zugriffs-Gewährungs-Information zugeordnet sind, **dadurch gekennzeichnet, dass** jeder der Downstream-Rahmen ein Überrahmen ist, der eine Matrix-Struktur mit Zeilen und Spalten hat, wobei ein erster Teil und ein zweiter Teil der Matrix-Struktur ein Kopfinformations-Teil (S, TCB), bzw. ein Informations-Teil (ATM) ist, und dass das Erzeugungs-Mittel so angepasst ist, dass es die Zugriffs-Gewährungs-Information in den Kopfinformations-Teil einfügt und die Größe des Kopfinformations-Teils entsprechend einem vorher festgelegten Größen-Wert, der aus der Zugriffs-Gewährungs-Information berechnet wird, flexibel anpasst.
2. Endgerät (TS1;...;TSn) für ein Zeitmultiplexsystem mit Vielfachzugriff, in dem eine Zentralstation (CS) mit einer Vielzahl von Endgeräten (TS1-TSn) gekoppelt ist, wobei jedes aus der Vielzahl der Endgeräte im wesentlichen gleich den anderen ist, wobei das Endgerät Empfangs-Mittel enthält, um einen Downstream-Rahmen (DS) zu empfangen, der von der Zentralstation über das System zum Endgerät gesendet wird, und Interpretations-Mittel enthält, um den Downstream-Rahmen zu interpretieren, wobei der Downstream-Rahmen Zugriffs-Gewährungs-Information (TEA1-TEA4) enthält, um es den Endgeräten zu erlauben, Upstream-Rahmen in Zeitschlitzten zur Zentralstation zu übertragen, die dazu mittels der Zugriffs-Gewährungs-Information zugeordnet sind, **dadurch gekennzeichnet, dass** jeder der Downstream-Rahmen (DS) ein Überrahmen ist, der eine Matrix-Struktur mit Zeilen und Spalten hat, wobei ein erster Teil und ein zweiter Teil der Matrix-Struktur ein Kopfinformations-Teil (S, TCB), bzw. ein Informations-Teil (ATM) ist, wobei die Größe des ersten Teils variabel ist, und dass das Interpretations-Mittel so angepasst ist, dass es die Zugriffs-Gewährungs-Information im Kopfinformations-Teil erkennt und interpretiert und dabei Informationen bezüglich der Größe des Kopfinformations-

ons-Teils berücksichtigt, wobei die Information entweder von der Zentralstation zum Endgerät übertragen oder vorkonfiguriert wird.

3. Rahmen (DS), der dazu geeignet ist, in einem Zeitmultiplexsystem mit Vielfachzugriff, das eine Zentralstation (CS) enthält, die mit einer Vielzahl von Endgeräten (TS1-TSn) gekoppelt ist, von der Zentralstation zu den Endgeräten übertragen zu werden, wobei der Rahmen Zugriffs-Gewährungs-Informationen (TEA1-TEA4) enthält, um es den Endgeräten zu erlauben, Upstream-Rahmen (US) zur Zentralstation zu übertragen, **dadurch gekennzeichnet, dass** der Rahmen (DS) ein Überrahmen ist, der eine Matrix-Struktur mit Zeilen und Spalten hat, wobei ein erster Teil und ein zweiter Teil der Matrix-Struktur ein Kopfinformations-Teil (S, TCB), bzw. ein Informations-Teil (ATM) ist, wobei der Kopfinformations-Teil die Zugriffs-Gewährungs-Information (TEA1-TEA4) enthält und die Größe des Kopfinformations-Teils variabel ist.
4. Rahmen gemäß Anspruch 3, **dadurch gekennzeichnet, dass** der Kopfinformations-Teil in zwei Teile unterteilt ist, von denen einer einen Fehlerkorrektur-Code enthält.

30

35

40

45

50

55

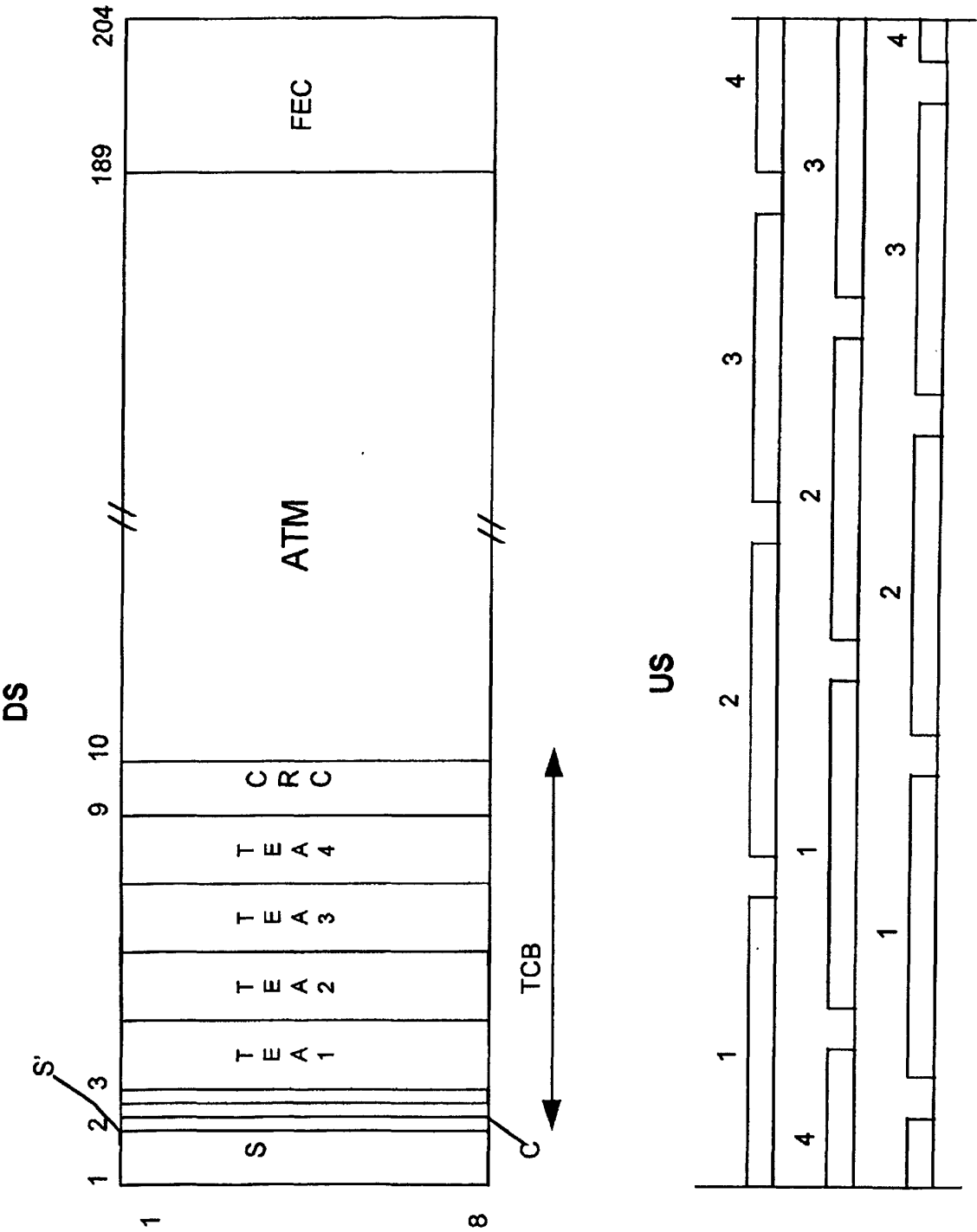


Fig. 1

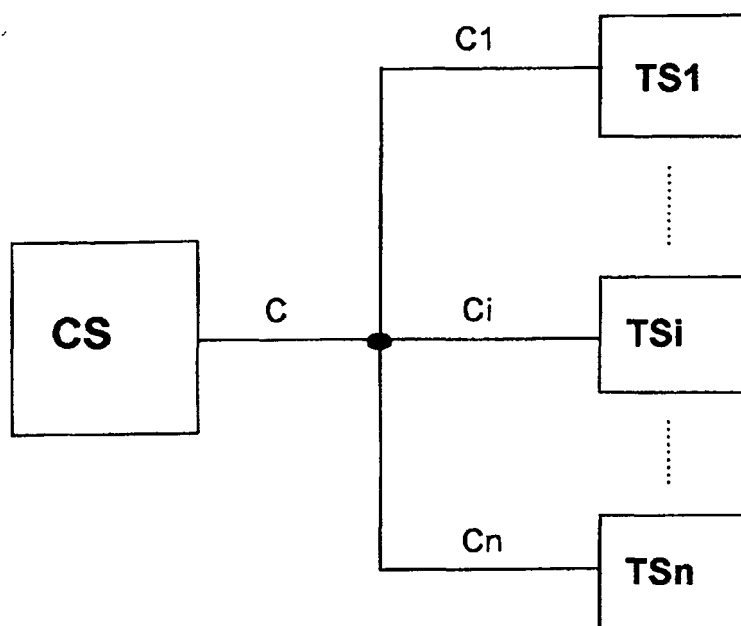


Fig. 2